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DRIP REDUCING NOZZLE AND METHODS

Field of The Invention

The field of the invention is fuel nozzles.

Background of The Invention

Gasoline and other fuel nozzles have a spout and a valve. The valve is typically located at the upstream end of the spout, leaving a distance within the spout in which the fluid can accumulate. This results in dripping, especially following dispensing of the fuel.

Dripping is a significant problem. The drips cause hydrocarbons to leak into the atmosphere, which can in turn causes severe air and water pollution. In addition to being bad for the environment, hydrocarbons are also known carcinogens which harm people, eat through car paint, and accumulate in soil and concrete; all of which can lead to land deterioration and infrastructure erosion that can cost millions of dollars to clean up and restore. Dripping can also cause huge resource and economic waste. The Environmental Protection Agency (EPA) and Air Resource Board (ARB) are expected to pass new laws regulating the amount of gas drips that will be permitted.

One approach to resolving dripping related problems is to locate the primary valve at the downstream end of the spout. Embodiments of this approach are described in US patent no. 4984612 to de la Haye (Jan. 1991), and US patent no. 5072862 to Keller (Dec. 1991). That approach, however, is not particularly practical. There is very little room at the downstream end of the spout, so that special valves need to be utilized. In addition to high cost and inherent unreliability, such valves are also subject to repeated physical insult during use.

Another approach utilizes a secondary valve at the downstream end of the spout. One class of secondary valves locates a pop-out component that is at least partially external to the spout. Examples are US patent no. 5603364 to Kerssies (Feb. 1997), and US patent no. 5377729 to Reep (Jan. 1995). Unfortunately, such devices are also inherently problematic. The pop-out portion tends to get stuck in the gasoline tank or other container, and are in any event readily subjected to damage. The use of a part that exits the spout also produces a very real problem of vandalism.

Another class of secondary valves are still located at the downstream end of the spout, but are wholly internal to the spout. These valves resolve some of the problems listed above, but produce yet other problems. A duckbill type of valve, depicted in US patent no. 5620032 to Dame (April 1997), can be difficult to install and/or replace, and necessarily leaves additional space around the valve that can accumulate fuel. Thus, the duckbill type of valve reduces the amount of dripping, but cannot realistically be expected to eliminate dripping. An internal ball valve, such as that shown in US patent no. 6520222 to Cbranchack et al. (Feb. 2003), poses a a problem in the event that the balls falls into the tank, and may even create a dangerous situation in the event that the ball becomes caught in the opening of the fuel tank. In any event ball type valves located at the end of the spout will still accumulate a few drops of fuel after fueling, which doesn't truly solve the original problem. A pinch valve, as shown in US patent no. 4214614 to Pyle (July 1980), likely has less room for fuel to accumulate, but has pressure problems. In order to open the pinch valve the pressure must be relatively high, which tends to disable the venturi automatic shutoff valve.

Thus, none of the prior art valve systems are practical to substantially eliminate dripping, while still providing adequate flow, pressure, and safety characteristics. There is a still a need for an adequate solution to these problems, and preferably a solution that is readily adaptable to existing nozzles.

Summary of the Invention

The present invention is directed to a nozzle having a diaphragm valve mounted at or near the downstream end of the spout.

In preferred embodiments the diaphragm is responsive to fluid pressure in the spout such that a portion of the diaphragm flexes as the pressure varies in the spout. It is especially desirable that the diaphragm flexes between a downstream position that opens the valve and an upstream position that closes the valve.

The diaphragm provides a fluid passageway, which is advantageously in the form of a opening. The opening can have any suitable shape and size, but is preferably multi-branched, with a central point from which side openings radiate. Examples are X and Y shaped openings, as well as star shaped openings. Other contemplated fluid passageways include a central curved opening, such as a circular hole, which can cooperate with a fixed ball or other object to close the passageway.

The diaphragm can be fabricated from any suitable material or materials, including for example a continuous piece of a polymer. Especially contemplated materials for this purpose are urethane, rubber, and silicone.

The diaphragm is preferably placed very close to the downstream end of the spout, and most preferably has a circumference which is attached at the terminus of the spout. This provides substantially reduced dead space between the diaphragm and the end of the spout. The diaphragm may or may not extend substantially normally across the spout.

At least a portion of the diaphragm must be flexible. Suitable diaphragms have sufficient flexibility such that during operation of the nozzle, a point of greatest travel of the diaphragm moves a relatively small amount, preferably less than 2 cm and more than 0.5 cm. Flexing of the diaphragm is preferably a passive function of changes in pressure of the fuel in the spout.

The diaphragm can be inserted into the spout in any suitable manner, but preferably the diaphragm is packaged within an installation frame to facilitate installation.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief Description of The Drawings

Fig. 1A is a vertical cross-section of a nozzle according to the inventive subject matter, in which the diaphragm is in a closed position.

Fig. 1B is a perspective view of the spout and diaphragm of Figure 1A, in which the diaphragm is in an open position.

Fig. 2A is a plan view of a diaphragm having a "Y" shaped opening, depicted in a closed position.

Fig. 2B is a plan view of a diaphragm having a "X" shaped opening, depicted in a closed position.

Fig. 2C is a plan view of a diaphragm having a star shaped opening, depicted in a closed position.

Fig. 2D is a plan view of a diaphragm having a donut shaped cutout, depicted in a closed position.

Fig. 3 is a vertical cross-section of a downstream portion of a spout nozzle in which the diaphragm forms a seal against a fixed ball.

Fig. 4 is a perspective view of the diaphragm of Figure 2B, depicted in an open position.

Fig. 5A is a perspective view of a diaphragm held within an installation frame, being inserted into the downstream end of a spout.

Fig. 5B is a vertical cross-section of a diaphragm in which the material is uniform in thickness.

Fig. 6A is a vertical cross-section of a diaphragm in which the material has been tapered with the middle being thinner.

Fig. 6B is a vertical cross-section of a diaphragm in which the material has been structurally reinforced with ribs.

Fig. 7 is a vertical cross-section of a diaphragm in which the cutout opening has been reinforced with a thicker segment of material.

Detailed Description

In **Figure 1**, a nozzle 10 generally comprises a spout 20, a head 30, and a handle 40. The specific details of the spout 20, head 30, and handle 40 are not critical to the inventive design. Virtually any models can be employed. As is normally the case, the head has a primary valve 32 that is actuated by a trigger 42 through linkage 44. Fuel or other fluid flows downstream in a path 12 through the hose 45, into the head 30, through the primary valve 32, and out the spout 20. The terminus 22 of spout 20 is depicted as dashed line 22.

The spout 20 is fitted with a diaphragm 50, which as best visualized in **Figure 1B**, generally has a body 52, a rim 54, and an opening 56. In Figure 1 the opening 56 would be in a closed position.

In most installations it is important that the rim 54 be positioned downstream of the opening 24 to return fuel line 25 leading to the venturi valve (not shown) near the primary valve 32. Otherwise the operation of the venturi valve could be compromised. Ideally, the

rim 54 is located at or near the end (terminus) 22 of the spout to minimize downstream "dead space" within the spout, within which gasoline or other dispensed fluid could accumulate. Alternatively, the rim 54 could be located upstream of the end 22, by any desired distance, such as up to a few mm, or even up to 1 cm, or more. The rim 54 can be held in place within the spout 20 by any suitable mechanism, including an installation frame (see Fig. 5 below).

In preferred embodiments the diaphragm 50 is responsive to fluid pressure in the spout 20 such that a portion of the diaphragm 50 flexes as the fuel pressure varies in the spout 20. The amount and location of flexing within the diaphragm 50 is a design choice. In one class of embodiments the center of the diaphragm 50 flexes the most, and travels between about 0.25 cm and about 2 cm. More preferably the portion having the greatest travel moves between about 0.5 and 0.75 cm. It is also contemplated that the majority of the diaphragm 50 flexes relatively little, and most of the flexing is accomplished by the leaves 57 of the opening 56B. (see Figure 4).

The fluid pressure needed to open the diaphragm is a matter of design choice. Clearly the pressure must be greater than one atmosphere, but need not be very high. Thus, it is contemplated that opening pressures could be less than 1.1, 1.2, 1.3, 1.4, or 1.5 atmospheres. It is also contemplated that embodiments might be utilized in which much higher pressures are required to substantially open the diaphragm, such as up to 5 atmospheres or more.

In most practical embodiments the opening 56 of diaphragm 50 is biased into a closed position, and flexes into an open position as a function of higher upstream pressure within the lumen of the spout 20, and then reverts back to the closed position when the upstream pressure falls below a given value. It is possible to have the diaphragm extend essentially straight across the lumen of the spout 20, but having the diaphragm bowed as shown in Figure 1 is thought to provide additional strength, durability, and consistency in operational parameters. It is also thought that having the body 52 of the diaphragm 50 biased into a bowed configuration assists in biasing the opening 56 into the closed position. This is especially true where there is residual upstream pressure, which actually assists in keeping the opening 56 closed.

On the other hand, it is contemplated that the diaphragm 50 could be bowed outward, extending downstream, and possibly even out the end 22 of the spout. Thus, it is contemplated that the diaphragm 50 could have any resting position, from extending

outwards (downstream), to extending substantially straight across the lumen of the shaft 20, to extending inwards (upstream).

The diaphragm 50 provides a fluid passageway, i.e., an opening 56 through which fuel can flow. The opening 56 can have any suitable shape and size, but is preferably multi-branched, with a central point are from which side openings radiate. **Figures 2A, 2B, and 2C** show "Y", "X", and star shaped openings, respectively. Other contemplated fluid passageways include a central or other curved opening, such as a circular hole, (See **Figure 2D**), which can cooperate with a fixed ball 34 held in position by stabilizer 35 (see **Figure 3**), or other object (not shown) to close the passageway.

A diaphragm can be inserted into a spout in any suitable manner. In **Figure 5A** a diaphragm 50 is packaged within an installation frame 80A to facilitate installation inside spout 20. Such a frame 80A can be fabricated or cast of any suitable material, but is preferably made of the material to the existing spout 20 to avoid expansion, cathodic dissolution due to redox reactions, and so forth. Preferred materials include nickel, aluminum, steel, and plastic. Installation frames are considered to be highly advantageous because they can be readily retrofitted into existing systems, and can readily adapt a standard diaphragm to substantially any nozzle size or shape. Installation frames can use any practical retaining apparatus or method, including, for example, springs, pressure fit, screw in, set screw, etc, all of which are depicted euphemistically by coupler 81. **Figure 5B** depicts an alternative embodiment in which an installation frame 80B couples to the outside the spout 20, rather than fitting entirely within the lumen of the spout 20.

Suitable diaphragms can be fabricated from any appropriate material or materials, including, for example, a continuous piece of a polymer. Especially contemplated materials for this purpose are urethane, rubber, and silicone. **Figure 6A** depicts a diaphragm 50E having rim 54 and a body 52E having a substantially uniform thickness designated by arrows 67-67. **Figure 6B** depicts a diaphragm 50F having rim 54 and a body 52F having a relatively greater thickness 62-62 nearer the rim 54, and a relatively lesser thickness 63-63 nearer the center of the diaphragm 50F.

Numerous other modifications are contemplated herein. For example, the edges of the leaves of the opening of a diaphragm can be reinforced with thicker material (not shown) than the remainder of the diaphragm, or with a different type of material. As another example, the edges of the leaves can overlap (not shown) or cooperate with one another in

some other manner to facilitate closure of the opening, or to increase durability and strength. In yet another alternative embodiment, **Figure** 7 shows a diaphragm 50G having opening 56A and ribbing 72 disposed radially over each of the three leaves of opening 56A.

Thus, specific embodiments and applications of drip reducing nozzle and methods have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. For example, the apparatus and methods described herein can be used for dispensing of toxic chemicals, or for many purposes other than gasoline delivery. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps can be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.